Autothermal Cyclic Reforming Based H_2 Refueling System

DOE Project Kick-off Meeting
Washington, D.C.

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GE Energy & Environmental Research
(GE Power Systems)
Praxair
BP
Hydrogen Components Inc.

Oct 30, 2001

Project Summary

Team

- Prime Contractor
  - GE Energy and Environmental Research: Autothermal Cyclic Reformer
- Subcontractors
  - Praxair: Pressure Swing Adsorption (PSA), H_2 Compressor & Storage Tanks
  - BP: Refueling Logistics
  - Hydrogen Components Incorporated: H_2 Dispenser

Contact Information

- Project Director/Principal Investigator

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Duration & Funding

- 4 year project
- $4.8 Million (Including Cost Share)

Technical Goals and Objectives

Design, optimize & validate a reliable & safe integrated H_2 refueling system based on Autothermal Cyclic Reforming (ACR)

Phase I – System Design & Analysis

- Design an ACR-based system
- Assess the technical & economic feasibility of the design
- Determine the competitiveness of the design relative to alternative concepts
- Identify a business model for commercialization

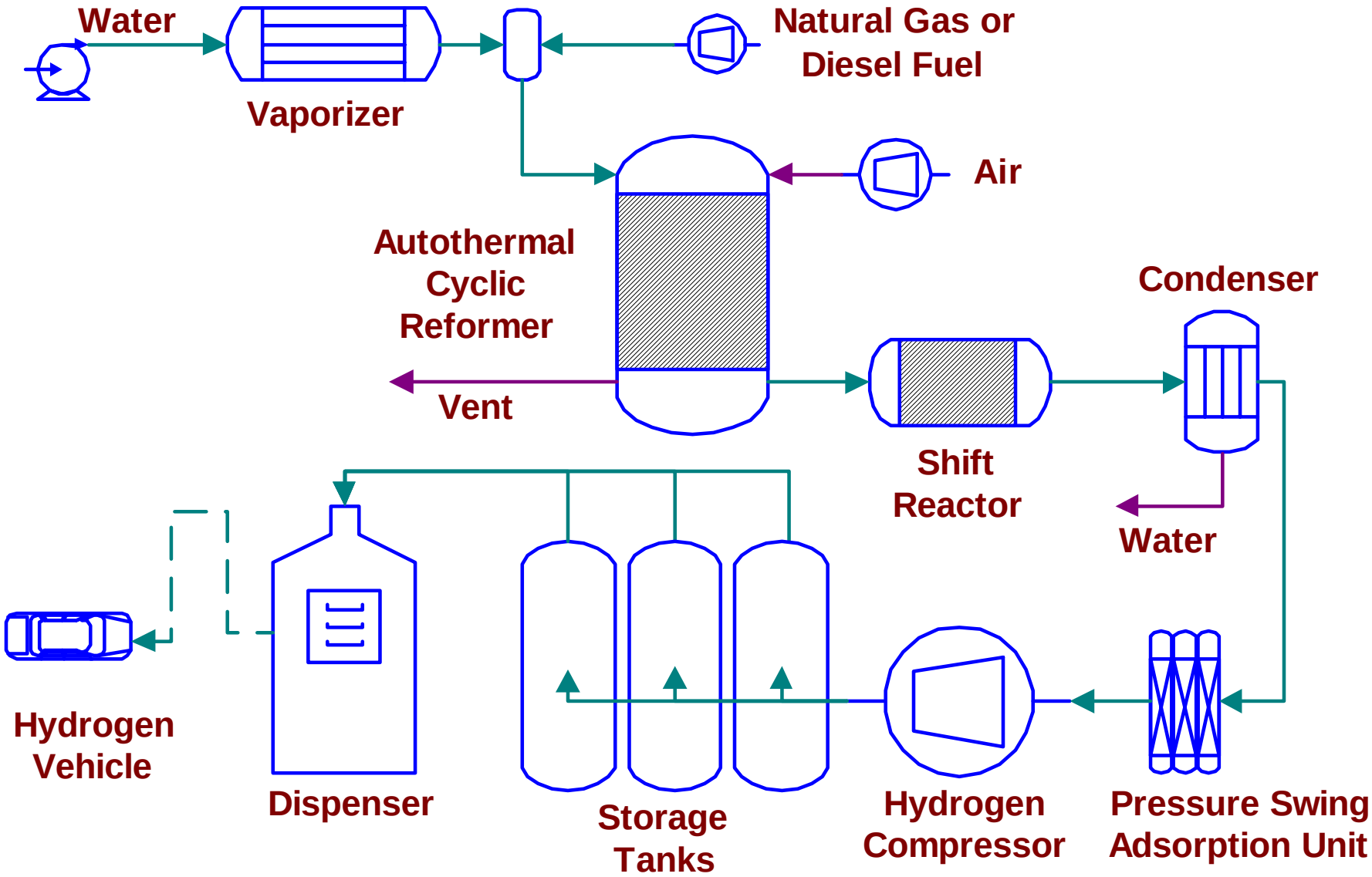
Phase II – Component Development & Integration

- Develop the critical components & subsystems to achieve the performance objectives
- Develop & test techniques to reduce the cost of components & subsystems critical to achieving the economic goal

Phase III – Prototype Fabrication & Demonstration

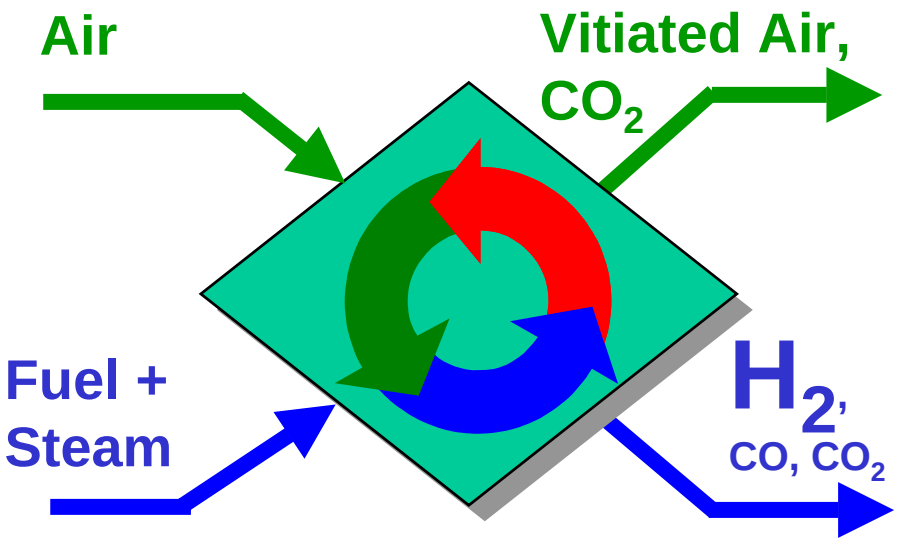
- Fabricate, install, & operate a H_2 refueling station safely
- Verify the operational performance of the integrated system
- Verify that the cost of producing & dispensing H_2 meets the targets

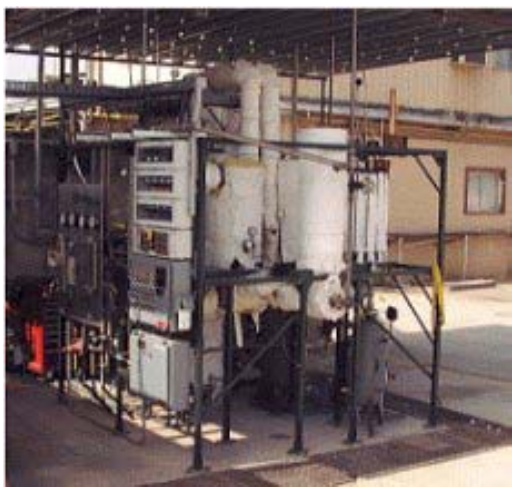
Technical Concept



Technical Concept: Reformer

Autothermal Cyclic Reforming





50kWe Fuel Processor For PEM Fuel Cells

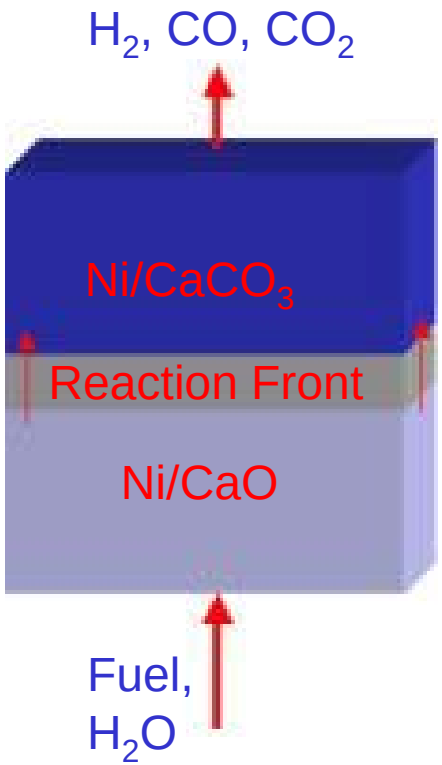
Autothermal Cyclic Reformer: Summary

- **Unique patented compact reformer**
  - Internal heat generation reduces capital cost and increases efficiency
  - High purity H_2
    - H_2 stream is not diluted with N_2
  - Fuel flexibility (sulfur tolerance)
    - Diesel Fuel
  - Coke burnt off during regeneration
- **Patent Status**
  - Three U.S. Patents Awarded
  - Two Additional Patents Pending

Stationary Power Project Status

- 50kWe Breadboard Reformer fabricated and successfully tested
- Program initiated along with DOE funding for pre-commercial prototype demonstration and integration with a PEM Fuel Cell

Step 1: Reforming (Endothermic)

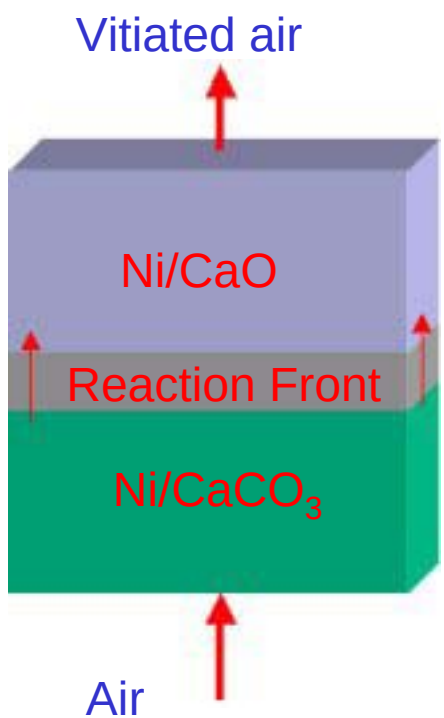


$CH_4 + H_2O \rightarrow CO + 3\,H_2$

$CO + H_2O \rightarrow CO_2 + H_2$

$CaO + CO_2 \rightarrow CaCO_3$

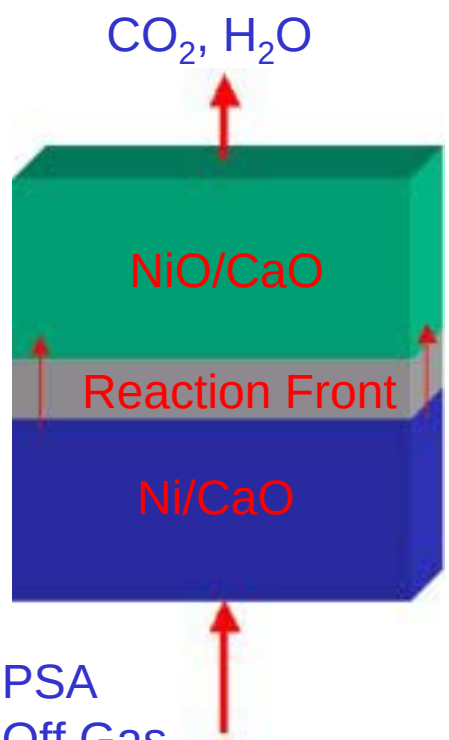
Step 2: Air Regeneration (Exothermic)



$Ni + 1/2\,O_2 \rightarrow NiO$

$CaCO_3 \rightarrow CaO + CO_2$

Step 3: Fuel Regeneration (Mildly Exothermic)

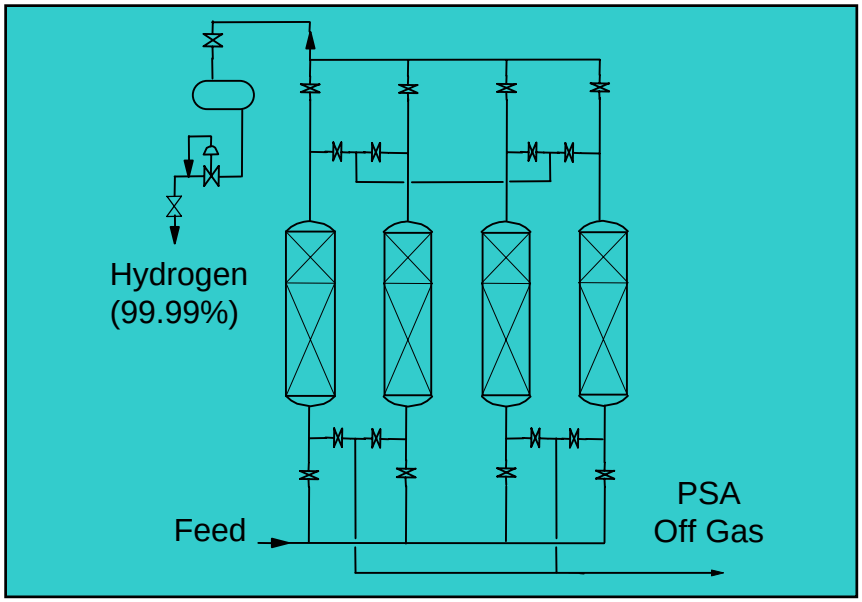


$NiO + 1/4\,CH_4 \rightarrow$

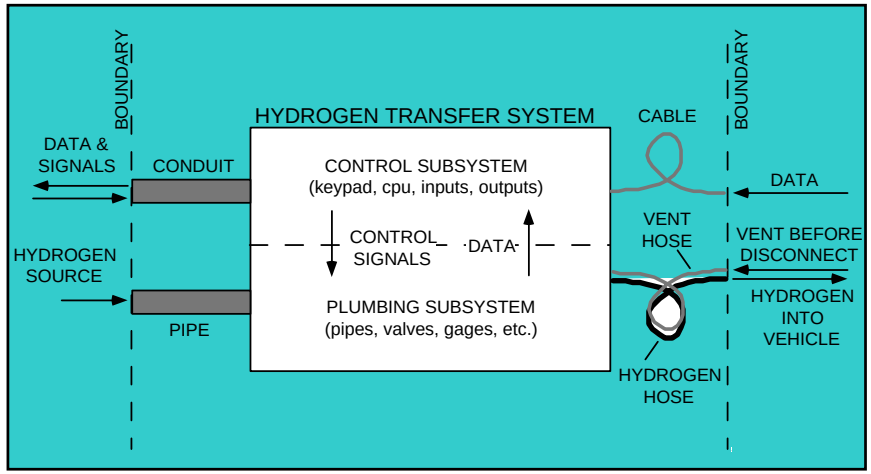
$Ni + 1/4\,CO_2 + 1/2\,H_2O$

Technical Concept: Balance of Plant

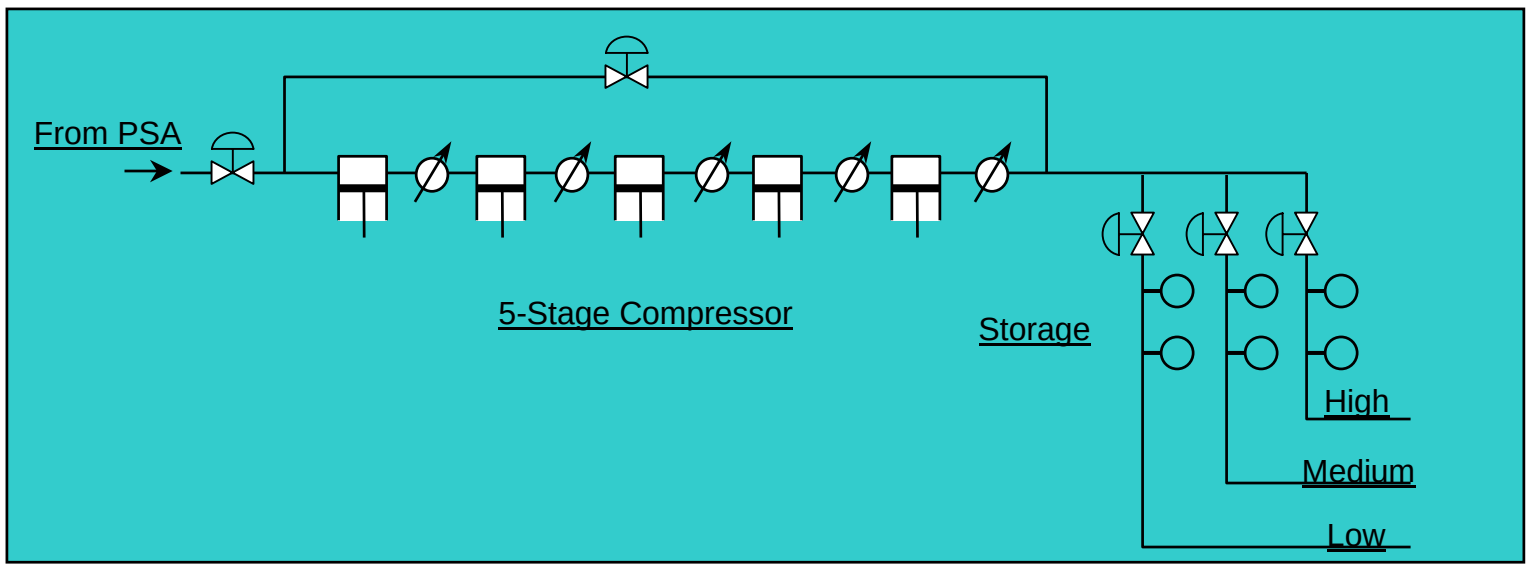
Pressure Swing Adsorption Unit (Praxair)



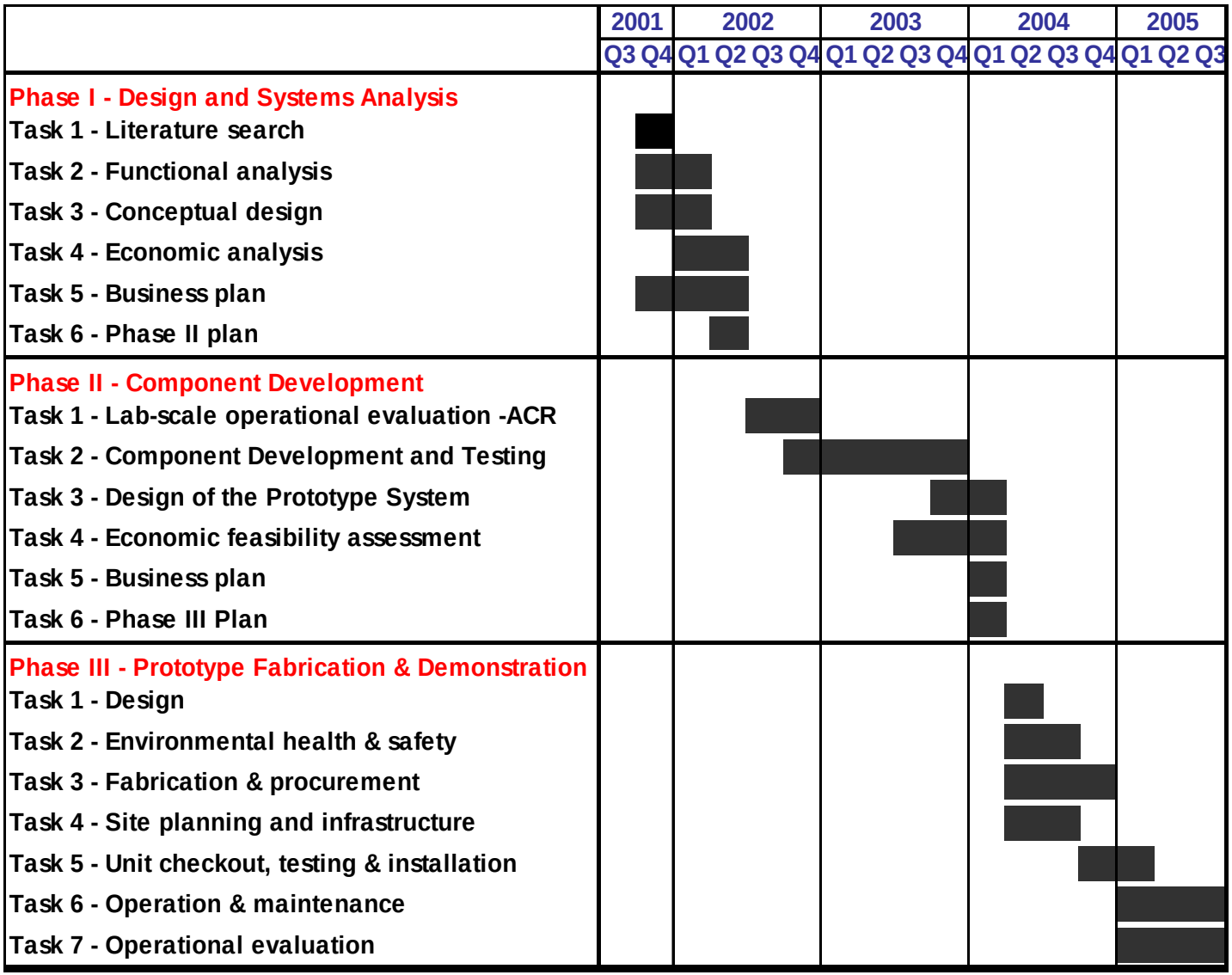
H_2 Dispenser (HCI)



H_2 Compressor & Storage Tank (Praxair)



Work Plan, Schedule & Milestones



Milestones

- 2002
  - Process Flow Diagram
  - P&ID
  - Economic Assessment
- 2003
  - Component Development
- 2004
  - Integrated System Fabrication
- 2005
  - Startup of Integrated System

Technical Success Assessment

- Technical Success will be based on ability to:
  - fast-fill vehicles with H_2 at pressures specified by the Partner Ship for New Generation of Vehicles (PNGV) program
  - produce and dispense at least 60 kg per day of H_2
  - dispense a H_2 stream that complies with ISO standard 14687 "H_2 fuel - Product Specification" (as per this specification CO contamination should be less than 5 ppm)
  - dispense a stream with H_2 concentration greater than 98%
  - operate with a system availability in excess of 90%
  - produce and dispense H_2 within the cost targets